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Population Variation and Food Habits of Ranid Frogs in the Rice-Based Cropping System in Gujranwala Region, Pakistan

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Abstract The current study aims to investigate the population variation and food habits of ranid frogs in the rice-based cropping system in District Gujranwala, Pakistan. The population in the study area was estimated using capture, mark and release method whereas food habits of the species were studied by analysis of stomach contents. The results showed the highest average population was found during August 2009 (93.10 ± 18.64 /ha) while the lowest from December 2008 to February 2009. Maximum seasonal populations existed in summer 2009, whereas winter 2008 sizes were at a minimum. Stomach content analysis of the species revealed percent frequency (% F) of occurrence of insects (80.3), earthworms (28.5), whole frogs (15.8), bone pieces (22.5), rodents (1.66), vegetation (5.0), soil particles (13.3) and some unidentified material (7.5) in all the stomach samples. Most frequently consumed prey items were insects (30% by volume), although frogs also preyed upon conspecifics and rodents. Insects recovered from the stomach contents were identified as belonging to Orthoptera, Lepidoptera, Coleoptera, Diptera, Odonata and Homoptera as well as the class Archnida. Insects recovered from the stomach contents were compared to those captured from the study area.

Keywords frog, paddy field, insect, diet

1. Introduction

The family Ranidae is ecologically quite diverse and comprises of approximately 500 species in the Oriental realm (Inger, 1999; Meegaskumbura *et al.*, 2002). Seven genera belonging to this family are found in Pakistan, including *Allopaa*, *Chrysopaa*, *Euphlyctis, Fejervarya, Hoplobatrachus, Nanorana,* and *Spharotheca* (Khan, 2006; Amphibiaweb.org). Two of these genera are found in Punjab Province, that is, *Hoplobatrachus* and *Euphlyctis*. The genus "*Hoplobatrachus"* is represented by *H. tigerinus* and "*Euphlyctis"* by *E. cyanophlyctis* in Gujranwala District of Punjab (Khan, 1976).

Hoplobatrachus tigerinus inhabits ponds and paddy fields, mainly cultivated areas and swampy wetlands (Kullman, 1974). It is the largest frog found in the plains of Pakistan. During winter and through the drought season, it hibernates by making burrows in the soil (Khan, 1969, 1996). Adults feed on a variety of prey, such as mice, shrews, young frogs, earthworms, juvenile snakes and small birds. It stalks its prey, while lying at the bottom of water, darting to catch it in its powerful jaws. The breeding activity of *H. tigerinus* is primarily confined to the monsoon season, which usually occurs from June till September every year. Males make specific calls to attract the females during breeding season. Calling males sit close to each other in shallow water and then jump over each other (probably a form of agonistic male-male competitive display to win over the calling points), while females lurch around (Khan, 1996).

The second species of the family Ranidae found in the paddy fields of Gujranwala is *Euphlyctis cyanophlyctis*. It is a highly aquatic and littoral frog. It is a permanent resident in different types of habitats with pooled water in the plains and sub-mountainous areas of Pakistan. Its tadpoles are commonly found in water bodies throughout the plains of Punjab and Sind, occurring from late February to mid September (Khan and Tasnim, 1987). *E.*

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cyanophlyctis feeds mainly on aquatic insects, beetles, tadpoles, dragonflies, and grasshoppers. It is known to emerge from the water at night and forage in the surrounding vegetation, and return to the ponds at dawn (Yadav and Pillali, 1975).

Most of the anuran species are predators and consume mainly invertebrates, whereas the large frogs also capture vertebrates (Pough *et al*., 2001). Frogs primarily feed on insects and in this way help control population sizes of harmful insects and their larvae. Since frogs themselves are preyed upon by snakes and birds, among others, they make up an important constituent of any ecosystem. Most of the true frogs eat insects and other invertebrates (Madhab and Ashok, 1980). They may sit and wait for prey or be active in their foraging mode (Duellman *et al.*, 1986).

The authors, through extensive literature searches, could find no formal scientific studies related to the ranid frogs of Pakistan. The IUCN status of both the species; *Hoplobatrachus tigerinus*, and *Euphlyctis cyanophlyctis* is "Least Concern (LC)". However, checklists of amphibian species found in this part of the world do exist and have been documented such as one by Khan (2006). Presently, no formal studies on the population variation of these frogs exist for the country. The current study was, therefore, designed to investigate the population estimates and diet composition of the ranid frogs inhabiting rice-based cropping system in Gujranwala region in Pakistan. The results of the current study will serve as a baseline data for long term monitoring of the ranid frog populations in the study region and their probable fluctuations in their populations due to various factors such as intensive agricultural practices and contamination by pesticides and insecticides.

2. Materials and Methods

2.1 Study area The current study was carried out in the paddy fields of the Gujranwala region, located at 32.16° N, 74.18° E with an elevation of approximately 65 m. Its plains receive scanty annual rainfall averaging 300 mm, most of which comes during the summer monsoon season. Summer temperatures exceed 42°C, while winter temperatures range between 8–10°C (Khan, 1999). Gujranwala is one of the major agricultural and industrial cities of Pakistan and its cultivation is dependent upon canal irrigation. The rural areas around Gujranwala produce a large variety of agricultural goods, with wheat, rice, cotton, barley and pearl millet being the chief crops. Cultivation of most rice crops in irrigated, rainfall and deep-water systems offers a suitable environment for fish and other aquatic organisms including frogs (Halwart, 2006).

2.2 Study design The study area consists of paddy fields (Figure 1), where three different sites were selected: Site-I (31°59′23.9″N and 74°27′26.1"E), Site-II (32°00′31.7″N and 74°25′50.9″E) and Site-III (32°00′42.8″N and 74°25′09.2″E). Study sites were separated from each other by a distance of 3 km. In the study sites, rice and wheat are grown alternatively in a single year by farmers, while *Alpha alpha* is grown as a fodder for cattle during a brief time period when these fields are empty.

Figure 1 Photographs showing the paddy fields in the study area. A. Showing a nursery of rice (*Oryza sativa*) for transplantation; B. Standing crop of the planted rice in the field

Each study site (I, II and III) had a size of 3 acres which was randomly assigned into 12 quadrats having pitfall traps for sampling purpose, with 36 sampling quadrats in the entire study area. Observations were recorded each month for one year starting from September 2008 to August 2009.

2.3 Population estimates The population of ranid frogs was estimated using "Capture, mark and release" method

(CMR) as described by Sutherland (1998). Pitfall traps were established in each sampling quadrat to capture the animals which were then marked by toe clipping following Szaniawaski and Adams (1974). Each pitfall trap consisted of a gallon "can" of approximately 25 cm (10 inches) in diameter, buried flush with the soil surface of the crop and a 96.8 cm^2 (15 $inch^2$) cover to support it. The traps were 6.35 cm (2.5 inch) above the soil. In total, 8 traps were placed in an "X" pattern in one acre of the cropland as described by Oldroyd (1958).

The study area was visited each month during the study period. Animals were captured at random by the pitfall traps, marked by toe-clipping and released unharmed back into the environment. On the next visit, the re-captured animals were counted for marked or unmarked. In this way, on each visit, the number of unmarked animals continued to decrease. Capture dates for the animals were recorded and at the end of the study period, the capture records were mathematically analyzed to estimate the population size and survival of the frogs by using the following formula following Saber (1982);

$$N=\frac{(M+1)(C+1)-1}{R+1}$$

where, N= Estimate of total population size, M= Total number of the animals captured and marked on the first visit, C= Total number of the animals captured on the second visit, R= Number of the animals captured on the first visit that were then recaptured on the second visit.

2.4 Investigation of feeding preferences The food habits of the frogs inhabiting the paddy fields were investigated through stomach content analysis as described by Hirai and Matsui (1999, 2001a). Frogs were collected each month from all three study sites in the morning. The trapped animals were euthanized by using chloroform swabbed cotton in a jar. Later, they were weighed and dissected to collect their whole stomachs, which were stored in 10 % formalin in a glass jar for further analysis. The carcasses of the frogs were buried. This is to mention here that no permits are required for capturing these species for research and education purposes under "The Punjab Wildlife Acts and Rules (1974)".

In the laboratory, stomachs were opened by dissection and analyzed for their contents which were separated by using the water displacement method. Various prey items such as arthropods, earthworms, and frogs, recovered from stomach contents were separated, identified, weighed, and photographed. Insect remnants recovered from the stomachs were identified up to the order level. For reference slide preparations, insect specimens from the paddy fields were captured using "sweep net" method as described by Bailey (1951). Insects captured in this way were preserved in alcohol and later on identified and analyzed. The reference slides were preserved in the Wildlife Laboratory of the Department.

2.5 Average temperature and annual rainfall Records of average temperature and rainfall at the study sites were obtained from the "Pakistan Meteorology Department," Lahore office. According to the data obtained, the average temperature of the study region was variable with a maximum temperature recorded during June 2009 (34.3°C) and a minimum average temperature during January 2009 (4.6°C).

Average minimum rainfall was recorded during November 2008 (0 mm), while 26.9 mm and 52.3 mm during January and February 2009, respectively. However, average maximum rainfall was obtained during July and August 2009 (110.9 mm and 287.2 mm, respectively), suggesting the occurrence of monsoon season in the study area.

2.6 Statistical analysis Data recorded for population estimates were statistically analyzed using one-way ANOVA, while data on both the insects (their orders) obtained from the stomach contents and those captured alive from the fields by sweep nets were analyzed using correlation analysis.

3. Results

3.1 Population estimates Average population sizes for the frogs at the three study sites in September 2008 was 33.33 ± 8.70/ha (Table 1), with a gradual decrease to 1.66 ± 1.67/ha in November of the same year. From December through to February, the population recorded was zero as no frogs were observed in the study area until March 2009 (1.50 ± 1.50/ha). Thereafter, an increasing population trend was noticeable through April (11.00 ± 3.01/ ha), May (22.567 ± 5.53/ha), June (46.13 ± 6.63/ha), July (72.43 ± 15.73/ha) and the maximum population was recorded in August 2009 (93.10 ± 18.64/ ha).

Seasonal fluctuations in the population of frogs were noticed (Figure 2). The average population at the three selected sites in autumn (August, September and October) was 285.57 ± 47.07/ha. It decreased to 1.67 ± 1.67 /ha in winter (November, December and January). The population began to increase again in spring (February, March and April) when it was found to be 31.20 ± 6.21/ha.

Table 1 Population density of the frogs (per hectare) at the three study sites from September 2008 to August 2009 estimated using the capture, mark and release method (CMR). Values expressed as mean ± S.E.

Month	Site I/ha	Site II/ha	Site III/ha	Mean ± SE
Sep	47.50 ± 0.05	35.00 ± 0.05	17.50 ± 0.05	33.33 ± 8.70^{bc}
Oct	12.50 ± 0.05	27.50 ± 0.05	17.50 ± 0.05	19.16 ± 4.41^{cd}
Nov	0.00 ± 0.00	0.00 ± 0.00	5.00 ± 0.05	1.66 ± 1.67^{d}
Dec	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00^{d}
Jan	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00^{d}
Feb	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00^{d}
Mar	0.00 ± 0.00	0.00 ± 0.00	4.50 ± 0.05	1.50 ± 1.50^{d}
Apr	8.50 ± 0.05	17.00 ± 0.05	7.50 ± 0.05	11.00 ± 3.01^{cd}
May	13.50 ± 0.05	21.60 ± 0.05	32.60 ± 0.05	22.567 ± 5.53^{cd}
Jun	41.60 ± 0.05	37.60 ± 0.05	59.20 ± 0.05	46.13 ± 6.63^{b}
Jul	100.50 ± 0.05	46.10 ± 0.05	70.70 ± 0.05	72.43 ± 15.73^{a}
Aug	126.60 ± 0.05	62.20 ± 0.05	90.50 ± 0.05	93.10 ± 18.64^{a}
Mean	29.22 ± 12.39	20.58 ± 6.19	25.42 ± 9.01	

*Superscripts with the same letter show non-significant difference.

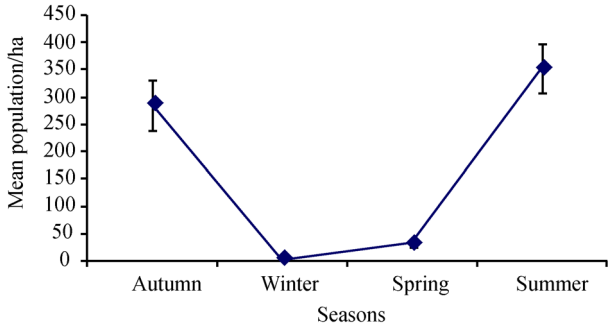

Figure 2 Average seasonal population of frogs/ha in the study area estimated by using the capture, mark and release method.

However, the maximum average population was found in summer (May, June and July), that is, 353.07± 44.81/ha.

The results of population recorded during different seasons of the study period were compared using two factors ANOVA and a significant difference ($p < 0.05$) was found among the seasonal populations at the three sites.

3.2 Food habits A total of 120 frogs (n = 120) were collected from all three study sites; 50 were from site I, 30 from site II and 40 from site III. The results from the analysis of stomach contents showed eight different kinds of prey items: insects, earthworms, other frogs, bone pieces of other vertebrates, rodents, vegetation, soil particles and some unidentified material (Table 2).

The percent frequencies (% F) of prey items recovered from the stomach contents of captured frogs showed insects 80.3%, earthworms 28.5%, frogs remnants 15.8%, bone fragments 22.5%, rodents 1.66%, vegetation 5.0% and soil particles 13.3% (both these components were obviously consumed along with their prey items), and unidentified material 7.5% (Table 2).

The percent volume (% V) occurrence of each food item (Table 3) recovered from the stomach contents was estimated (Figure 3). The insect parts on average per sample accounted for 30.46 %, earthworms 11.68 %, frogs pieces 25.07 % (Figure 4), bone pieces 13.30 %, plant parts 7.91%, soil particles 8.05 % and unidentified material 7.01 % (Figure 5).

The main prey items consumed by the frogs in the study area were insects and also some arachnids (Table 4). The insects recovered were identified up to the order level, including Orthoptera (4.14 ± 1.08), Lepidoptera (2.16 ± 0.52), Coleoptera (1.83 ± 0.59), Diptera (2.27 ± 0.44), Odonata (2.06 ± 0.06), Homoptera (2.97 ± 0.34) and the class Archinda (1.64 ± 0.32).

We also estimated the prey availability in the study area by using sweeping net method to capture the live insects from the three study sites (Table 4). The average numbers of different insects captured from the study sites were 8.83 ± 1.63 for Orthoptera, 5.36 ± 0.37 Lepidoptera, 4.41 ± 1.30 Coleoptera, 5.00 ± 1.42 Diptera, 2.64 ± 0.65 Odonata, 7.47 ± 1.71 Homoptera, and class 2.31 ± 0.12 Archinda.

A correlation analysis was performed between the

Table 2 Mean percent frequency (% F) of the prey items recovered from the stomach contents of the frogs collected from the three study sites

Food item	Site -1 (n =50)	Site-II (n =30)	Site-III (n =40)	Mean % F of prey (n = 120)
Insects	92 (46)	90 (27)	82.5 (33)	80.3(106)
Earthworm	58 (27)	33.3 (10)	52.5 (21)	28.5 (58)
Frog pieces	16 (8)	20 (6)	12.5 (5)	15.8(19)
Bone pieces	22 (11)	26.7 (8)	20 (8)	22.5 (27)
Rodents	4 (2)	0	0	1.66 (2)
Plant parts	4 (2)	10 (3)	2.5 (1)	5 (6)
Soil	10 (5)	23.3 (7)	10 (4)	13.3 (16)
Unidentified	4 (2)	6.6 (2)	12.5 (5)	7.5 (9)

Table 3 Mean percent volume (% V) of the prey items recovered from the stomach contents of the frogs collected from the three study sites.

Food item	Site-I (n =50)	Site-II (n = 30)	Site-III (n = 40)	Mean (% V) (n =120)
Insects	30.50	31.80	29.10	30.46
Earthworms	10.24	15.20	9.60	11.68
Frog pieces	25.07	22.40	17.30	21.59
Bone pieces	16.41	14.40	11.60	13.30
Plant parts	5.22	6.50	14.40	7.91
Soil	5.64	8.90	9.60	8.05
Unidentified	6.58	6.31	8.15	7.01

Figure 3 Photographs of the invertebrate prey items recovered from the stomach contents of the frogs captured from the three study sites.
A. Grass hoppers (Orthoptera); B. Bugs (Homoptera); C. Flies (Diptera); D. Beetles (Coleoptera); E. Water Striders (Arachnida); F. Earthworms (Oligochaeta)

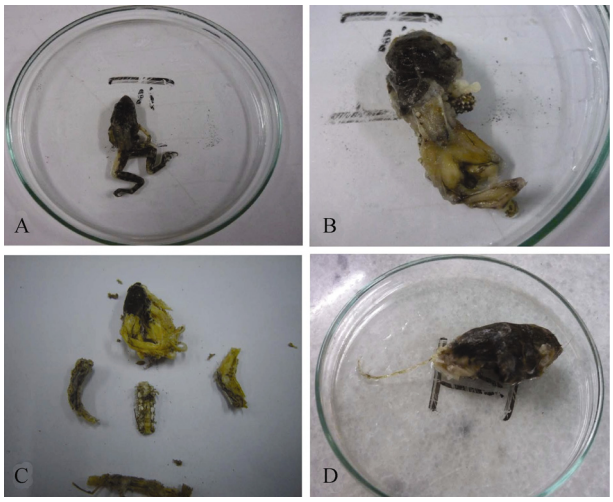

Figure 4 Photographs of the vertebrate prey items recovered from the stomach contents of the frogs captured from the three study sites.
A. Complete, undigested frog recovered from the stomach of a frog indicating the phenomenon of cannibalism; B. Showing partially digested frog; C. Skull and bones of another frog recovered from the stomach contents; D. A complete, undigested mice *(Mus musculus*) recovered from the stomach contents of a frog captured from study site I.

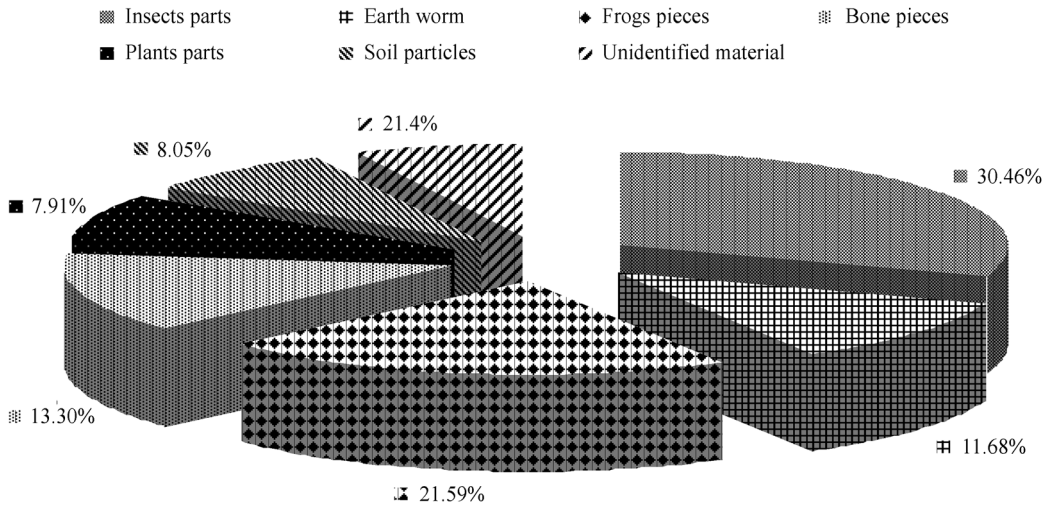

Figure 5 Mean prey items (% V) recovered from the stomach contents of the frogs captured from the three study sites.

Table 4 The insects recovered from the stomach contents of the frogs and captured alive from the three study sites from September 2008 to August 2009. Values are expressed as Mean ± S.E.

	Recovered from the stomach contents of frogs				Captured alive from the three study sites			
	Site-I	Site-II	Site-III	Mean	Site-I	Site-II	Site-III	Mean
Class Insecta								
Orthoptera	5.91± 0.05	4.33 ± 0.05	2.18 ± 0.05	4.14 ±1.08	12.08 ± 0.05	7.17 ± 0.05	7.25 ± 0.05	8.83 ± 1.63
Lepidoptera	2.92 ± 0.05	2.42 ± 0.05	1.17 ± 0.05	2.16 ± 0.52	6.08 ± 0.05	4.83 ± 0.05	5.17 ± 0.05	5.36 ± 0.37
Coleoptera	3.00 ± 0.05	1.08 ± 0.05	1.42 ± 0.05	1.83 ± 0.59	7.08 ± 0.05	3.42 ± 0.05	3.00 ± 0.05	4.41 ± 1.30
Diptera	3.67 ± 0.05	2.33 ± 0.05	2.33 ± 0.05	2.27 ± 0.44	7.75 ± 0.05	4.25 ± 0.05	3.00 ± 0.05	5.00 ± 0.42
Odonata	1.13 ± 0.05	1.44 ± 0.05	1.15 ± 0.05	2.06 ± 0.06	11.12 ± 0.05	10.67 ± 0.05	9.21 ± 0.05	2.64 ± 0.65
Homoptera	2.92± 0.05	3.58 ± 0.05	2.42 ± 0.05	2.97 ± 0.34	10.33 ± 0.05	7.67 ± 0.05	4.42 ± 0.05	7.47 ± 1.71
Class Archinda	1.08 ± 0.05	2.25 ± 0.05	1.58 ± 0.05	1.64 ± 0.32	7.12 ± 0.05	8.12 ± 0.05	6.34 ± 0.05	2.31 ± 0.12

insects collected from the study sites and those obtained from the frog's stomach contents. A strong correlation was found between the Orthoptera (r = 0.867), Coleoptera (r = 0.967) and Diptera (r = 0.968) from the stomach contents and those captured from the study sites, suggesting a strong positive correlation for each of the insect orders. However, the values of "r" for Arachnida (0.626), Lepidoptera (0.519) and Homoptera (0.477) suggested a relatively weak positive correlation among them.

4. Discussion

Seven genera of the family Ranidae occur in Pakistan (Dubois, 1992), and two of them are found in the Province of Punjab, represented by *H. tigerinus* and *E. cyanophlyctis* in District Gujranawala (Khan, 1976). Unfortunately, this important group of vertebrates has not received thorough attention in Pakistan, although some checklists of the species occurring here are available. Therefore, it emphasizes that if we have to focus this particular group and monitor the populations of the species in this region for a longer period of time, some baseline studies must be conducted first.

Paddy fields are one of the major breeding sites of amphibians throughout the plains of Punjab and Sind in Pakistan. During the monsoon season, the paddy fields get filled with water and are invaded by several amphibian species. Water level is also maintained in the fields through an irrigation system which allows these species to complete their reproduction and development (Khan, 1990). The population estimates of the two species of Ranid frogs from the three study sites during the study period (from September 2008 to August 2009) show variable densities. The average monthly population was

recorded least from December 2008 to February 2009 (in winter), the important reason speculated being the environmental temperature (8.3°C, 4.6°C and 12.5°C, respectively) in the area forcing them to opt for hibernation. During winter, the soil of the study sites at few places was dug to confirm the presence of hibernating frogs (data not shown). After February 2009, when the temperature began to rise (March and onward), the frogs started repopulating the study sites. The average population recorded in June 2009 was 46.13 ± 6.63/ha.

At the same time, monsoon season brought great amount of precipitation to the area as is evident from the annual rainfall record obtained from the Pakistan Meteorological Office, showing approximately 120 mm in July and around 300 mm in August 2009. Accordingly, the population increases in July and rises to a maximum level recorded during the particular year in all the three study sites. The data on seasonal population fluctuations showed that winter harbour the least (Since no frogs were sighted in the fields due to hibernation), while summer has the maximum average population. The abundant rainfall during the monsoon season as well as the increase in environmental temperature provides an opportunity for these frogs to breed as they usually synchronize with such conditions. It results in a 9 fold increase in mean density for the frogs during the summer as compared to that in the spring.

So the two major factors, temperature and annual rainfall, in the study region seem to influence the population of the frogs. However, it has been noticed that the temperature of the study area is on the rise on average for the last few years, while the annual rainfall is decreasing compared to the previous records. Further studies are needed to understand how this changing climate is influencing the population of the frogs in this region.

The population of the frogs in the study area needs to be monitored on regular basis since the study area is an important place where various pesticides are being sprayed in the paddy fields. Therefore, the current study will serve as baseline data for future investigations that focus on the effects of pesticides on frog populations. The authors could find only one study for this region through literature retrieval, that is, Khan and Malik (1987) who studied the subtropical anuran populations in arid Punjab, Pakistan. According to them, for *E. cyanophlyctis*, the calling season started in February and early March when few stray individuals began calling in the afternoon. It followed eventually by evening calling as evening temperatures reached an optimum. For the particular species, vocalizations began where the air temperature reached a range of 12–15°C rather than rainfall. These results show that in March frogs do come out of hibernation and start their normal activities.

According to Hirai and Matsui (1999), Ranid frogs predominantly feed on invertebrates including arthropods, mollusks, and annelids. Five different classes of arthropods, insecta, arachnida, crustacea, chilopoda and diplopoda make up to 96% by number and 84% by volume of the total prey items of the Ranids in this study. Insects alone make up to 77% by number and about 71% by volume of the total Ranids' prey items. Ants (Formicidae) contribute the largest proportion in number, followed by beetles (Coleoptera) and other insects. By volume, beetles make up the largest proportion, followed by caterpillars and earthworms (Oligochaeta). Although ants dominate in number, they represent only a minute fraction by volume. However, in the present study, the analysis of stomach contents show that frogs consume on average eight different kinds of prey items, including insects, earthworms, frogs, bone pieces, rodents, plant parts, soil particles and some unidentified materials. The maximum prey items consumed in percent frequency (% F) of occurrence among all stomach samples are various types of insects (80.3%). The second most abundant prey items recovered are earthworms which constitute 28.5%. Conspecifics also contribute in a reasonable percent while rodents represent only a minor fraction. Balint *et al*., (2008) have shown that Marsh frogs (*Rana ridibunda)* in Romania often eat conspecifics and other amphibians, as well as small reptiles and even small birds and rodents. According to their results "cannibalism" becomes especially severe during the period of low humidity and precipitation as well as high temperature. However, they demonstrated that the most essential prey categories in their studies included bugs, flies, spiders and mosquitoes. They also showed that other prey categories consumed in low amounts were earthworms, snails, isopods, grasshoppers, butterflies and mimetic flies. In the current study, the results have also shown that ranid frogs also preyed upon the other ranid frogs.

In the current study, the average number of insects of different orders recovered from the stomach contents of the frogs captured from all the study sites included Orthoptera (4.14 ± 1.08), Lepidoptera (2.16 ± 0.52), Coleoptera (1.83 ± 0.59), Diptera (2.77 ± 0.44), Archinda (1.64 ± 0.32), Odonata (2.06 ± 0.06) and Homoptera (2.97 ± 0.34). In a similar study, Johnson and Christiansen (1976) showed that arthropods found in the stomach con-

tents of *Acris crepitans blanchardi* (Blanchard's Cricket Frog) included Chilopoda, Crustacea and Insecta, accounting for 1.0%, 10.7% and 85.7%, respectively. Among the insects, the Diptera accounted for 20.2% of total volume, while Coleoptera and Homoptera for 11.9% and 10.5%, respectively. In the current study the average number of the arthropods of different orders captured from the study sites included Orthoptera (8.83 ± 1.63), Lepidoptera (5.36 ± 0.37), Coleoptera (4.41 ± 1.30), Diptera (5.00 ± 1.42), Odonata (2.64 ± 0.65), Homoptera (7.47 ± 1.71) and Archnida (2.31 ± 0.120. So the most frequently consumed order in both the cases, obtained from the stomach contents of frogs and captured from the study sites, is Orthoptera. According to Cicek and Mermer (2006) *R. ridibunda* mainly consumes invertebrates, especially terrestrial prey belonging to arthropod groups (75.17%). The most frequently consumed prey items with respect to their numeric proportion were Diptera 19.85%, Coleoptera 12.72% and Hymenoptera 10.02%. Similarly, Hirai and Matsui (1999) showed that five different classes of arthropods including Insecta, Arachnida, Crustacea, Chilopoda and Diplopoda, made up to 96 % by number and 84 % by volume of the total prey items of the ranids. However, in the current study seven different classes of arthropods instead of five, Orthoptera, Lepidoptera, Coleoptera, Diptera, Arachnida, Odonata, and Homoptera, were recovered from the stomach contents of the frogs, as well as the members of these seven different orders were captured by sweep nets from the paddy fields.

The results of the current study provide the first formal record about the population, food habits and prey species of the Ranid frogs in the rice-based cropping system of Pakistan. It will be beneficial for long term future studies, monitoring the population of the frogs in relation to different factors like pesticides, reduction in annual rainfall and temperature changes in the region.

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